Tracking Accuracy

Khalid Baheyeldin — Sep 23 #5190

So, after months of work, I have an OnStep controller, as I explained in this post.

I tested it under the stars, and for short exposures, it works well.

But I continue to try to push further to see what the limits are.

The motor is the MPJA NEMA11 with an 18:1 gear head, and 1:1 belt and pulleys to the worm gear.
The worm period for the mount is 480 seconds.

So I took an exposure that is 960 seconds (two rotations), of Albireo (with a known distance between A and B of 34 arc seconds). The result is attached.

There is no PEC yet on this mount (neither with a sensor, nor with parking only).

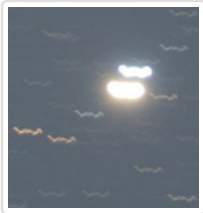
Look at the two orange stars on the left below center.

There is a large wave which is due to periodic error.

The question is: what are the smaller fluctuations?

Any ideas?

My configuration is posted on the link above.



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Khalid Baheyeldin — Sep 23 #5191

Attached is Albireo, 960 seconds, last week, with much better polar alignment.

Much better for a 16 minute exposure, unguided of course.

Could the small fluctuations be still there, but not visible because of better polar alignment?

One thing that is different from last week and today is that I wiped the EEPROM on the controller (tried to set park position to Az 270 Alt 0, but scope would still reset to NCP when I do an alignment).

After that reset, I see PEC defaults to ON in KStars (but can't be sure if it was that way before or not).

More

Howard Dutton — Sep 24 #5226 Edited Sep 24

I don't know what's going on there but it's not isolated to just the RA axis and "tracking."

Unguided imaging is unforgiving. Even if the mount is perfect there can still be no bending or wobble or other movement of the OTA/optics/focuser/camera. These things need to be stable in a "beyond human perception" kind of way. No walking around the scope tripod. How much of a breeze is ok? Cables from camera shift. Etc. Etc. Etc.

More

Ant No — Sep 26 #5243

Khalid

I may be misunderstanding what I'm looking at in the first picture but if the big wave is your periodic error do you know it's period?

This would let you work out the frequency of the small fluctuations which might give you a clue to what's causing them.

Maybe.

Anthony

...

More

Khalid Baheyeldin

Sep 26 #5245

On Tue, Sep 25, 2018 at 07:54 PM, Ant No wrote:

> if the big wave is your periodic error do you know it's period?

The big wave should be the period of my worm gear, which is 480 seconds (8 minutes).
This wave shows well in the blue component of Albireo.

The image was made over 960 seconds, so two full worm rotations.

> This would let you work out the frequency of the small fluctuations which might give you a clue to what's causing them.

I am still stumped by what causes those small oscillations. I only saw them when the polar alignment was way off (hence the long streak left to right over 960 seconds).

If my measurements from the image are correct, the distance between Albireo A and B is 34 arc seconds (from the edge of one to the corresponding edge of the other). Using this measurement, the oscillations have a distance of around 4 arc seconds.

More

hitosi sato

Sep 26 #5252

Hi Khalid

High frequency PE error offen caused by the eccentricity of the pulley for the belt or gears.
Additionaly It also caused by the precession of the worm screw.
There are many mechanical causes of PE errors.
If you can download this paper(Sorry this paper written in Japanaese, Famous mount maker's report about PE error)
ttp://www.u-han.co.jp/u-150/U-150.pdf
Please look at the pictures of this document. You can imagine about PE error.

you should try to record the guide log and check the details in a PHD log viewer etc.

Hitosi

More

Dave Schwartz

Sep 26 #5257

Another source of RA tracking error can be introduced by the (small, but never zero) backlash in the worm-to-ring-gear interface.

The reason is that, if you have west-heavy bias (and we consider frictionless bearings for now), the ring gear teeth will be pressed against the east side of the worm teeth. Sidereal tracking will be acting to lower the worm tooth allowing the scope to 'fall' as it would like to do. Now seeing that all most of the mounts we use will have a property known as stiction in the axis bearings, the axis will not actually move the fractions of an arcsec in the backlash until the west side of the worm tooth closes it up and then shoves the gear to the west. Then the scope's bias and/or inertia will rotate the gear through those backlash fractions of arcsecs, reopening the backlash, until it is stopped by again hitting the east side of the worm teeth.Then the process keeps repeating and the period is not necessarily constant or related to the periodic error frequency. This also happens when the RA axis is neutrally balanced due to the stiction alone.

To address this, your RA axis should always have a slight east-heavy bias. In this case, the ring-gear is always pressed against the west side of the worm teeth and the sidereal tracking motion of the motor is always acting to push the ring-gear against its natural 'fall' direction and stiction. The backlash therefore never opens up and the rotational error is strictly due to the periodic error.

More

Khalid Baheyeldin

Sep 28 #5296

Hitosi,

Thank you for your suggestions.

On Wed, Sep 26, 2018 at 09:58 AM, hitosi sato wrote:

> High frequency PE error offen caused by the eccentricity of the pulley for the belt or gears.

In my case, the pulleys cannot be a source of the high frequency observed in the photo that
shared with the group.

The reason is: the pulleys in my case are 1:1, so whatever errors are in the pulleys will be in step with the worm gear rotation.

> Additionaly It also caused by the precession of the worm screw.

If you mean the worm gear itself, then that is the lower frequency wave (one rotation every
480 seconds, and two rotations in the original photo.

> There are many mechanical causes of PE errors.
> If you can download this paper(Sorry this paper written in Japanaese, Famous mount maker's report about PE error)
> http://www.u-han.co.jp/u-150/U-150.pdf
> Please look at the pictures of this document. You can imagine about PE error.

Thanks. The diagrams are informative.

> you should try to record the guide log and check the details in a PHD log viewer etc.

It may be the gearbox on top the NEMA11 motor (which is 18:1).

Howard mentioned Declination as well, but I don't completely understand that. Perhaps
I should try another time night with an option to power down the Dec axis and see ...

More

Khalid Baheyeldin

Oct 20 #5674

Edited Oct 20

On Sat, Sep 22, 2018 at 11:24 PM, Khalid Baheyeldin wrote:

> I took an exposure that is 960 seconds (two rotations), of Albireo (with a known distance between A and B of 34 arc seconds). The result is attached.
>
> There is no PEC yet on this mount (neither with a sensor, nor with parking only).
>
> Look at the two orange stars on the left below center.
>
> There is a large wave which is due to periodic error.
>
> The question is: what are the smaller fluctuations?

An update on the above.

On Oct 4th, I took two images of Albireo (2018-10-04-a, and 2018-10-04-b), unguided.
Each is 480 seconds, which is one full worm rotation.
Same night, same OnStep alignment model, same balancing.
The difference between them is that -b has better polar alignment.
Nothing else changed.

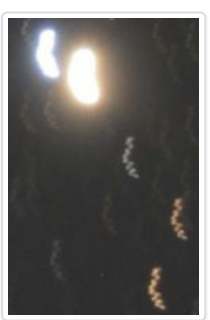
The high frequency zigzag pattern (in the two orange stars) are visible.

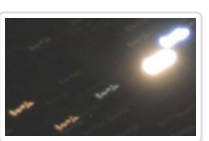
Last night (Oct 18th), I did the same test, 480 seconds, and Albireo.

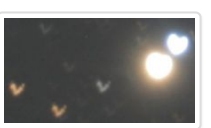
The low frequency (worm period) is more pronounced (higher amplitude), but the high frequency pattern is completely gone. No explanation as to why.

Last night, I spent some time balancing the scope better in RA and DEC.
The new version of the Android App reported an alignment error of 17 and 19 arc minutes, if that matters.

The conclusion is that the tests are inconclusive ...







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Howard Dutton

Oct 20 #5678

~18 arc minutes off the NCP might be good enough for some guided imaging but with 4 or 8 minute unguided you will see trails.

I'd shoot for about < say 4' and see what you get then.

More

Khalid Baheyeldin

Oct 20 #5679

I will try that, though clear nights will be scarce between now and March.

A question on polar align error: when doing alignment in OnStep and then displaying the error values. If I then change the polar alignment, do I have to repeat the alignment procedure for OnStep? I imagine it is necessary to do so.

The puzzle is the high frequency wave, and why it was apparent on both shots on Oct 4th, but not on Oct 18th?

More

Howard Dutton

Oct 20 #5680

If the goal is to quantify the performance...

A guide camera and a PHD2 log file is how I approach it, turn on logging and turn off guide output.

Take said log file and have a look at it in PECPrep.

More

Howard Dutton

Oct 20 #5681

On Sat, Oct 20, 2018 at 11:22 AM, Khalid Baheyeldin wrote:

> If I then change the polar alignment, do I have to repeat the alignment procedure for OnStep?

Yes.

There are ways (two ways around this) but they are more experimental and lets not cloud the issue.

More

Howard Dutton

Oct 21 #5693

...you should perhaps do a drift align session before alignment.

More

Howard Dutton

Oct 25 #5715

Edited Oct 25

I mentioned about tracking and there being two ways "around" the polar alignment accuracy requirement for unguided imaging.

One has to do with an experimental command in OnStep that has you center on a bright star, zeros the PZ and PE alignment terms, then does a goto back to the star. You then center the star with the mount's polar alignment adjustments.

The other way is to not bother aligning the mount accurately but use OnStep's dual axis pointing model compensated tracking. Again an experimental feature but since we're on the subject I did some tests of this feature Monday night and also last night. It seemed to have problems during the first tests and oddly (because I saw it working in simulation) showed tracking was drifting in Sky Planetarium also. The errors on the first images were in Declination and so I wondered about the sign reversal and pier side. After adding a little code to deal with that I did some testing.

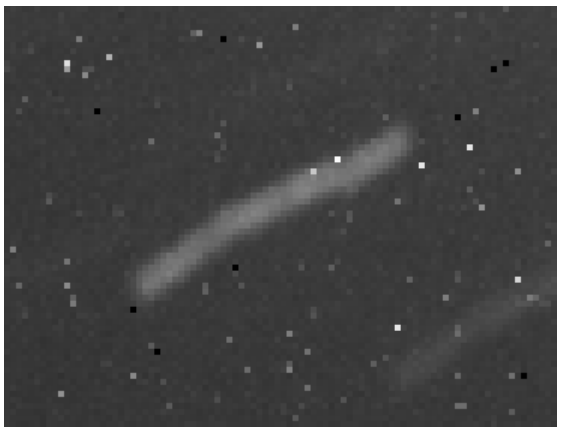
For this test we want a really bad polar alignment so I just sat the mount down and pointing roughly at Polaris. After a 3-star align OnStep said I was 125' to the right and 3' below the NCP. It was windy out and focus was pretty bad but I was more concerned about the goal than taking pretty pictures. Also, one image set was East of the Pier and the other West. The camera was orientated so that the RA axis is mostly up/down and Dec left/right. Declination for both was about 40 or 50°N. These are all stacks of 4x 1 minute exposures (no registration so the equal of a single 4 minute exposure for showing drift.) The before/after images show tracking with no compensation to the left and tracking with full pointing model compensation enabled (dual axis) to the right.

East:

West:

Probably more alignment stars would help (as would being a bit closer to the NCP than ~2 degrees off) but obviously something good is happening.

For comparison to star trails in Khalids images my images to the left have star trails of about 100 arc-seconds length. The high frequency noise is not present from what I can tell (keeping in mind these are the same MPJA 18:1 NEMA11 stepper motors and LV8729 drivers on this LXD75.) The following shows the full 2 arc-seconds/pixel (blown up 4x)...



The latest Alpha branch OnStep on Github has the code I added last night.

More

Khalid Baheyeldin

Oct 25 #5723

Thanks a lot Howard for working on this.

So, to use this, I need to:

- Upgrade to latest Alpha.
- Align using polar scope, best I can
- Align OnStep on 3 stars (or more)
- In the Android App, select Tracking -> Compensated Tracking -> Full -> Dual Axis

That is it?

Unfortunately, the forecast is continuous clouds for the next 10 days. Let us hope it changes by the last quarter moon (31st).

More

Howard Dutton

Oct 25 #5726

That's it.

This feature with dual axes mode ON should be useful for getting the most out of any unguided imaging.
If guiding, you probably want to turn dual axis off due to backlash.

More

Khalid Baheyeldin

Oct 25 #5727

This awesome feature makes OnStep closer to features of high end rigs such as Software Bisque's Paramount unguided imaging with TPoint software (here is their write up on telescope pointing).

Can't wait to try it ...

More

George Cushing

2:54am #5728

+1 on that. Khalid, you must be getting this stuff a few hours before we do. It's nice to have the jet south of us for a change, but that just opens the door to central Canada.

More

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